



# Using Remote Sensing Tools to Target Stream Protection and Wastewater Treatment BMPs in Rural Kentucky



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# Project Background

## ► Hinkston Creek Watershed Based Plan

- CWA 319 Project
- In support of KDOC/KDOW
- Several reaches within the watershed were identified as impaired for fecal coliform, sedimentation/siltation, and/or nutrient/eutrophication biological indicators

*(2012 Integrated Report to Congress on the Condition of Water Resources in Kentucky)*

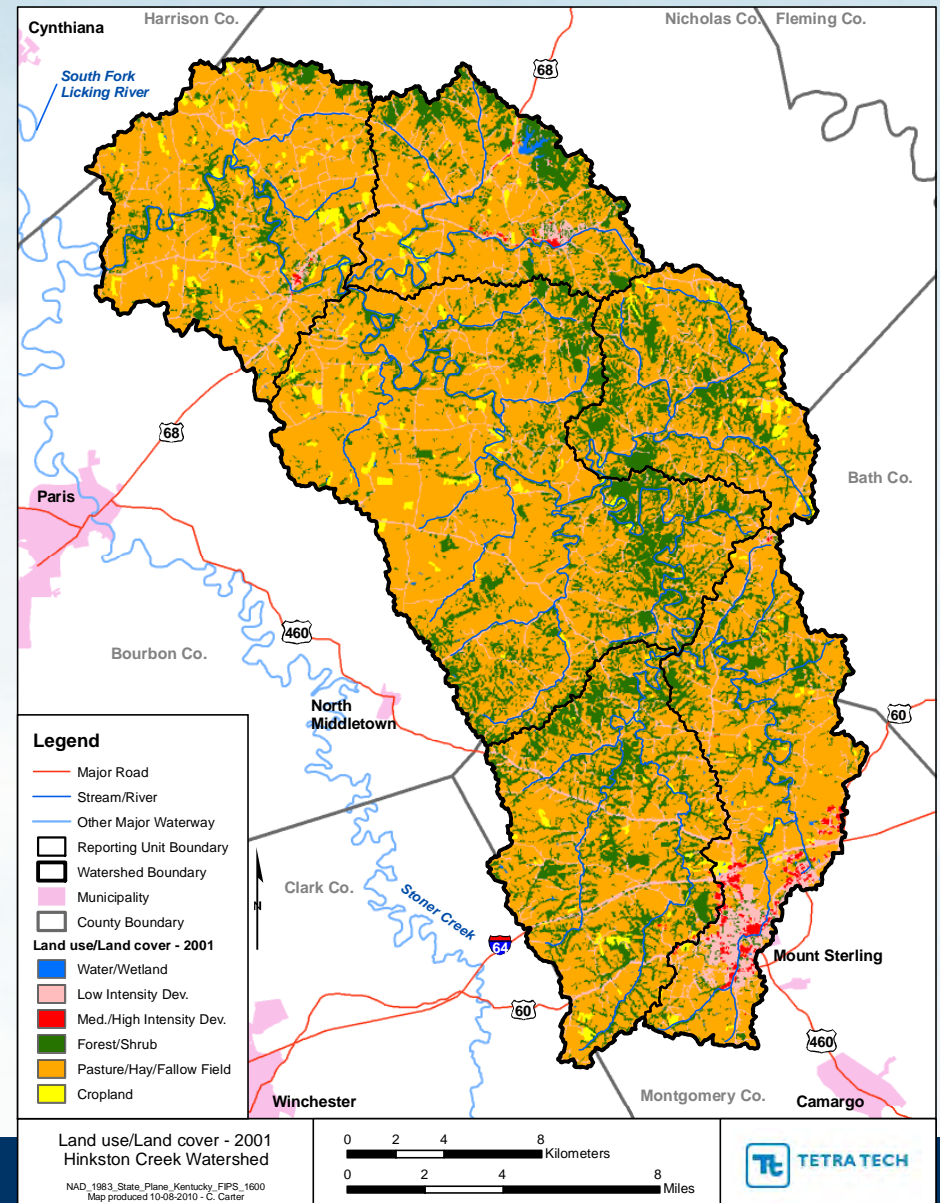
### Hinkston Creek Watershed Assessment and Management Plan

Prepared for:  
Kentucky Energy and Environment Cabinet  
Department for Natural Resources  
Division of Conservation  
Frankfort, Kentucky



# Hinkston Creek Watershed

- ▶ Located in east central Kentucky
- ▶ 260 mi<sup>2</sup>
- ▶ Land Use Land Cover:
  - 72% pasture/cropland
  - 20% forest/shrub
  - 8% developed
- ▶ <1 percent high intensity development
- ▶ Primary urban center is Mt. Sterling (pop. = 6800)



# Use of Remote Sensing Tools

- GIS mapping
- Aerial photography
- Tailored analysis



Identify  
high-risk  
areas



Identify  
pollutant  
sources and  
target  
management  
practices

# Outline



Onsite wastewater system  
risk analysis



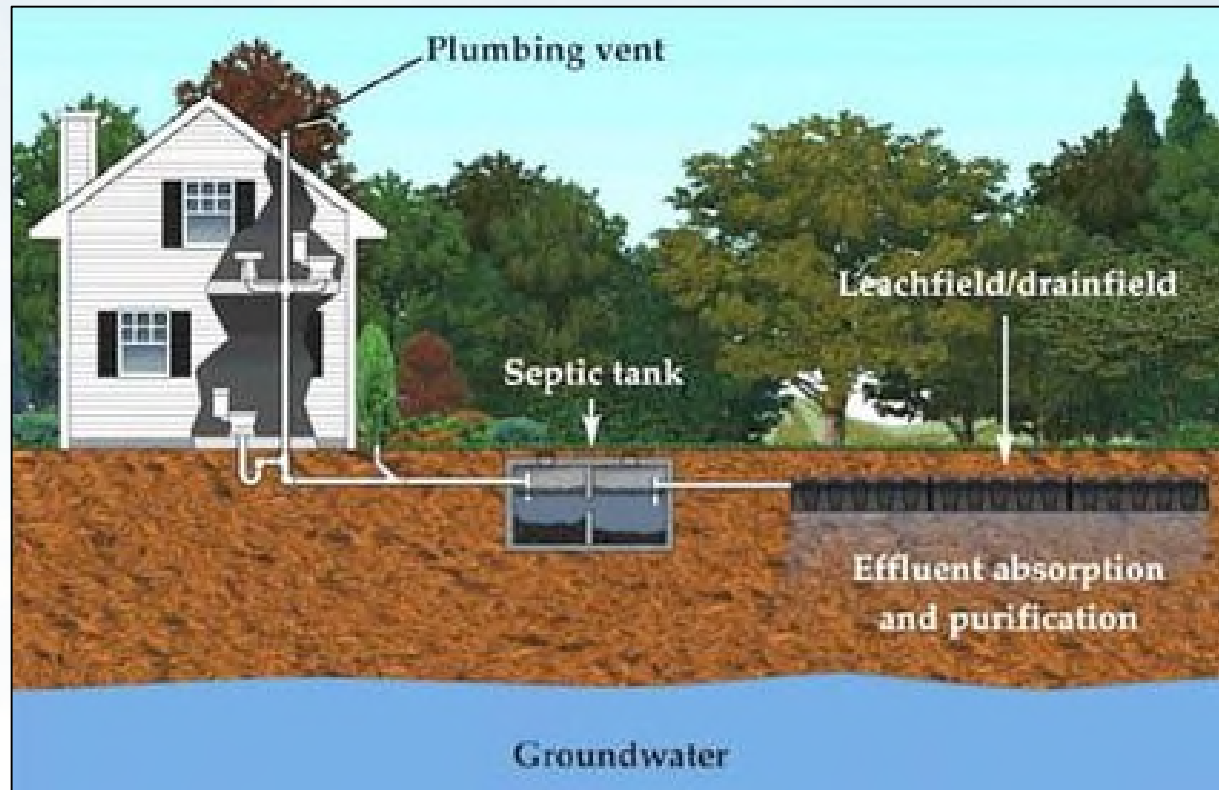
Riparian buffer assessment  
and deficiency analysis



High-risk stream  
channel assessment

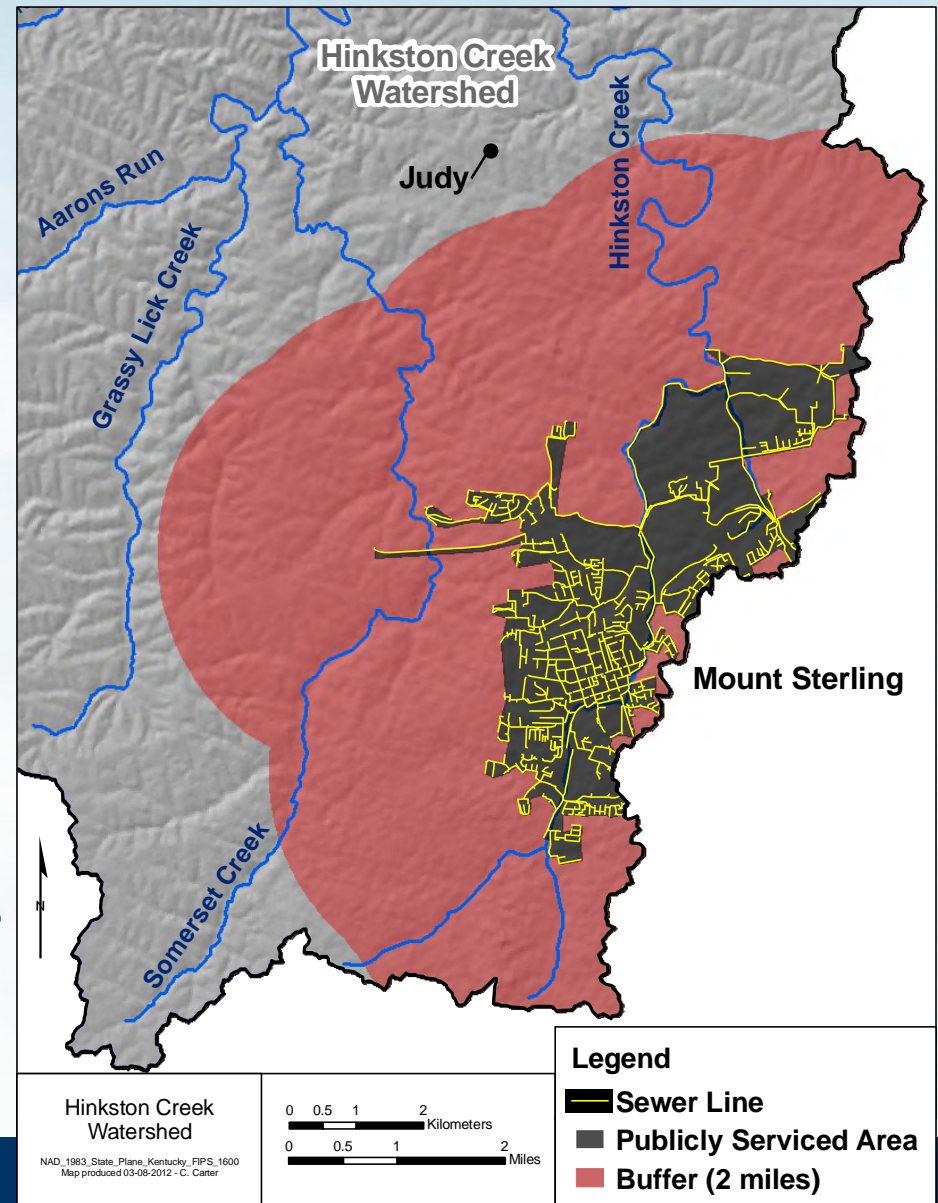
# Onsite Wastewater System Risk Analysis

- Malfunctioning septic systems are a concern for nonpoint source (NPS) pollution in the watershed



# Onsite Wastewater System Risk Analysis

- ▶ Areas of interest:
  - Exclude publicly serviced areas
  - Include areas within 1-2 miles of publicly serviced areas where >1house/acre
- ▶ Spatial attributes:
  - Household density
  - Closeness to streams
  - Closeness to karst topography

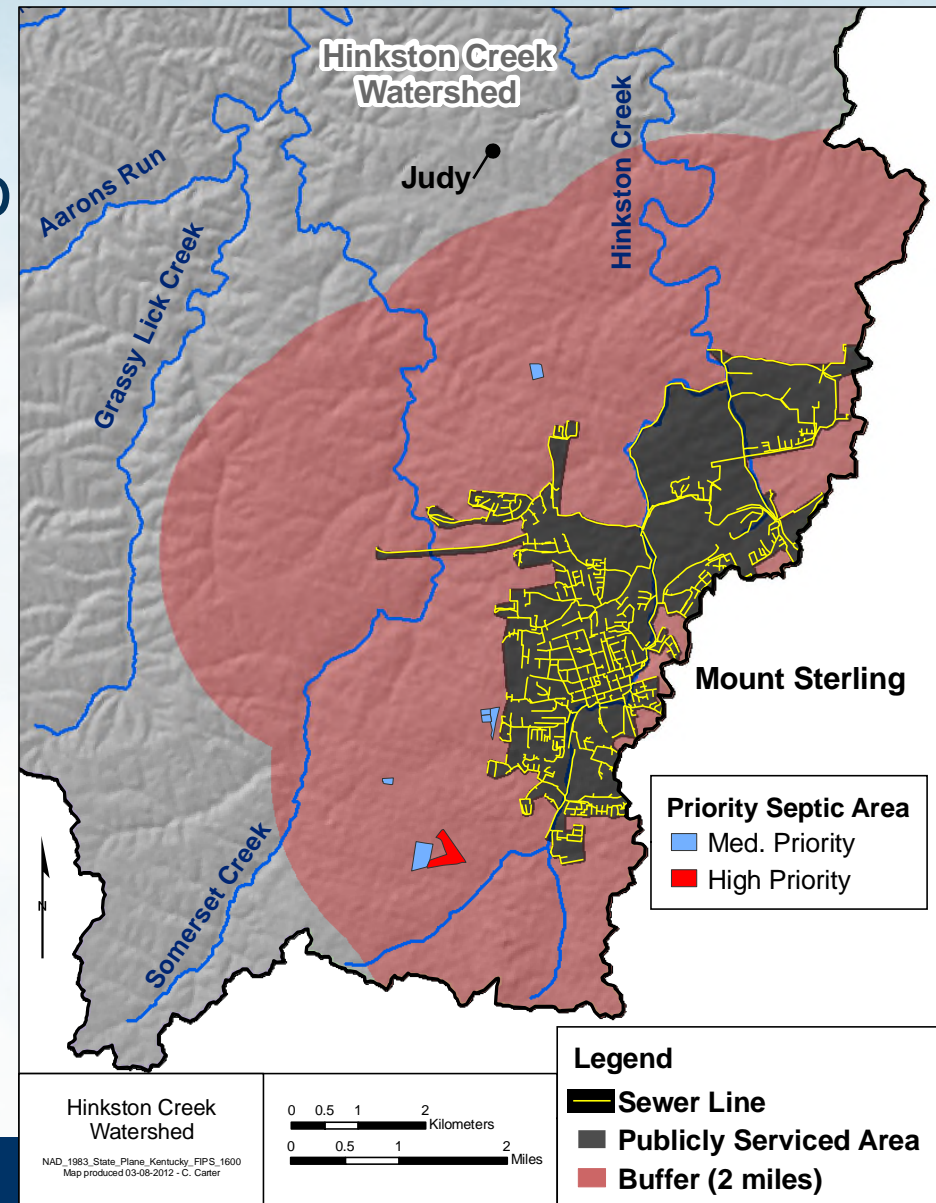


# Onsite Wastewater Systems: Risk Analysis Data

- ▶ Areas serviced by centralized wastewater treatment
  - Water Resources Information System, which is supported by the Kentucky's Area Development District and KDOW
- ▶ Household density
  - U.S. Census Bureau's 2000 Census Block data
- ▶ Closeness to streams
  - High resolution streams data layer created by the United States Geological Survey (USGS) as part of the National Hydrography Dataset
- ▶ Closeness to Karst topography
  - Geologic data layer developed by the Kentucky Geological Survey

# Onsite Wastewater System Risk Analysis

- ▶ Prioritization and Results
  - Applied equal weight to each of the three attributes
  - Areas with highest potential to contribute NPS pollution to streams and/or near-surface groundwater
- ▶ Subsequent analyses
- ▶ Target for management



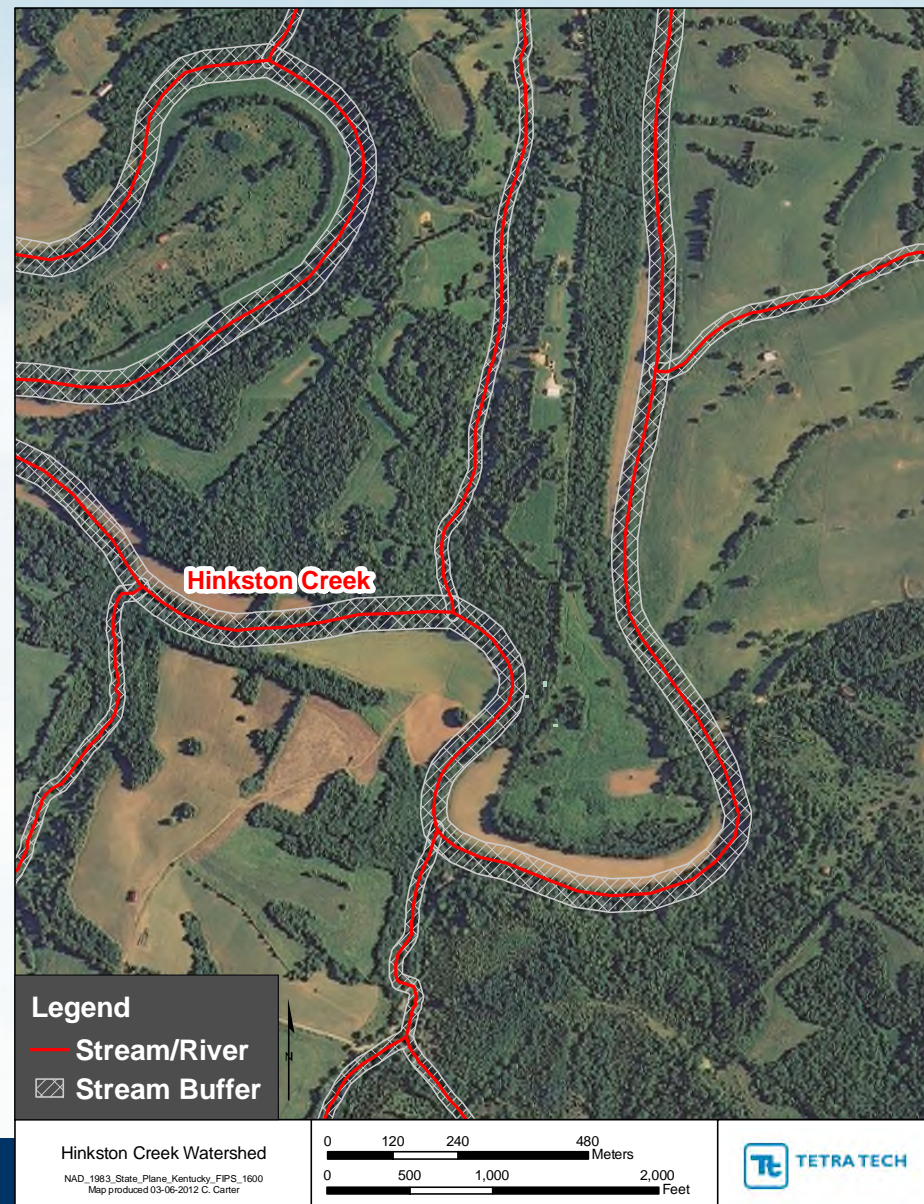
# Riparian Buffer Assessment and Deficiency Analysis

- Analysis of riparian buffer deficiency served as a method for identifying riparian areas throughout the watershed that were either intact or impacted



# Riparian Buffer Assessment and Deficiency Analysis

- ▶ Area of interest:
  - Riparian areas
  - 50 or 100-ft stream buffer
- ▶ Spatial attributes:
  - Riparian buffer health status
    - Impacted = impacted land use type, <30% canopy cover
    - Intact = >30% canopy cover



# Riparian Buffer Assessment and Deficiency Analysis: Data

## ► Buffered streams

- High resolution streams data layer created by the United States Geological Survey (USGS) as part of the National Hydrography Dataset

## ► Percent vegetation cover in buffer

- Data product used – Existing Vegetation Canopy
- From a Multi-Resolution Land Characteristics Consortium (MRLC) mapping program known as the Landscape Fire and Resource Management Planning Tool (LANDFIRE)
- Procedures for development: satellite enabled remote sensing, predictive landscape modeling

# Riparian Buffer Assessment and Deficiency Analysis

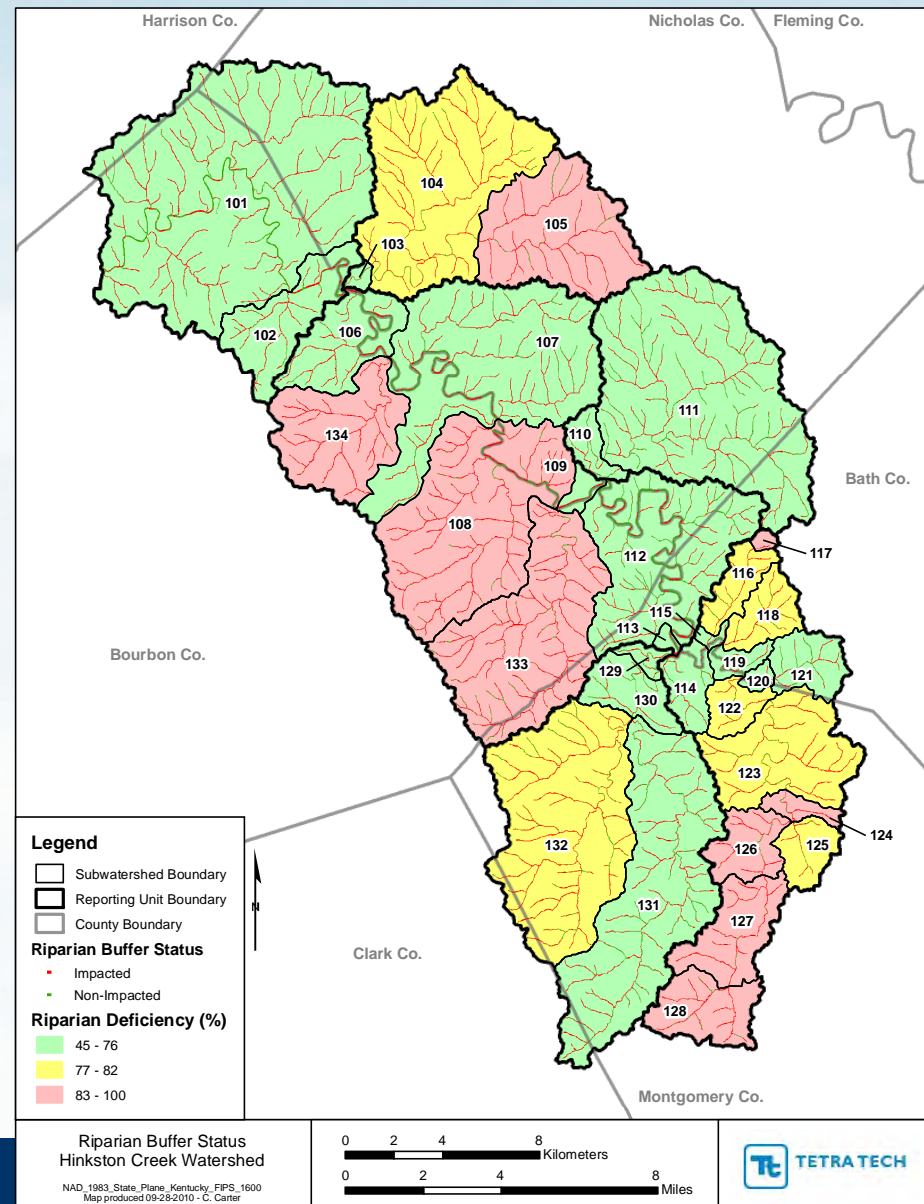
$$\text{Percent impacted buffer} = \text{Buffer deficiency}$$

## ► Results

Watershed-wide:  
75% deficient

Subwatershed level:  
45 to 100% deficient

## ► Highlight subwatersheds of greatest concern for impacted riparian buffers



# High-risk Stream Channel Assessment

- ▶ In a watershed with  $>90\%$  riparian buffer deficiency, it is often a challenge to target initial management efforts



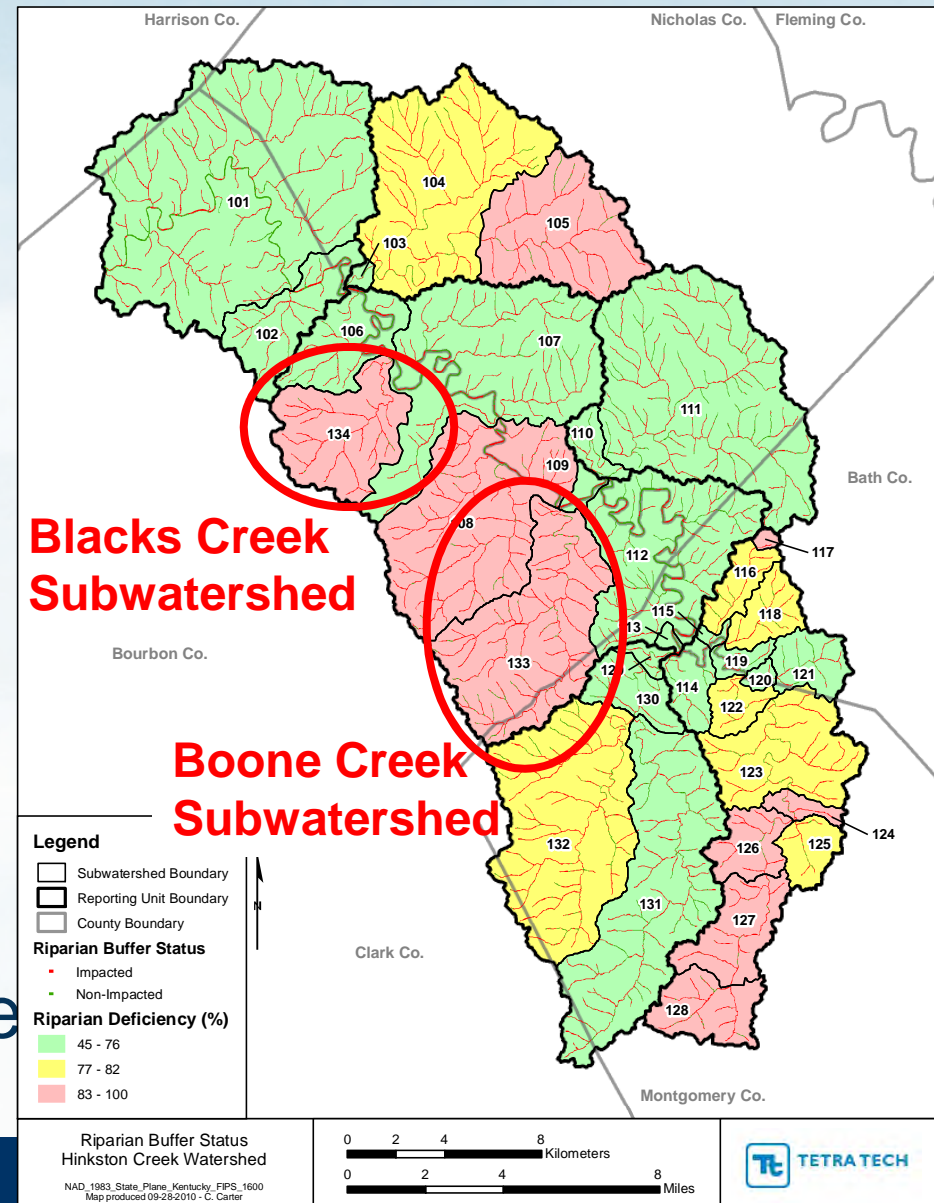
# High-risk Stream Channel Assessment

## ► Area of interest:

- 2 subwatersheds, with >80% buffer deficiency

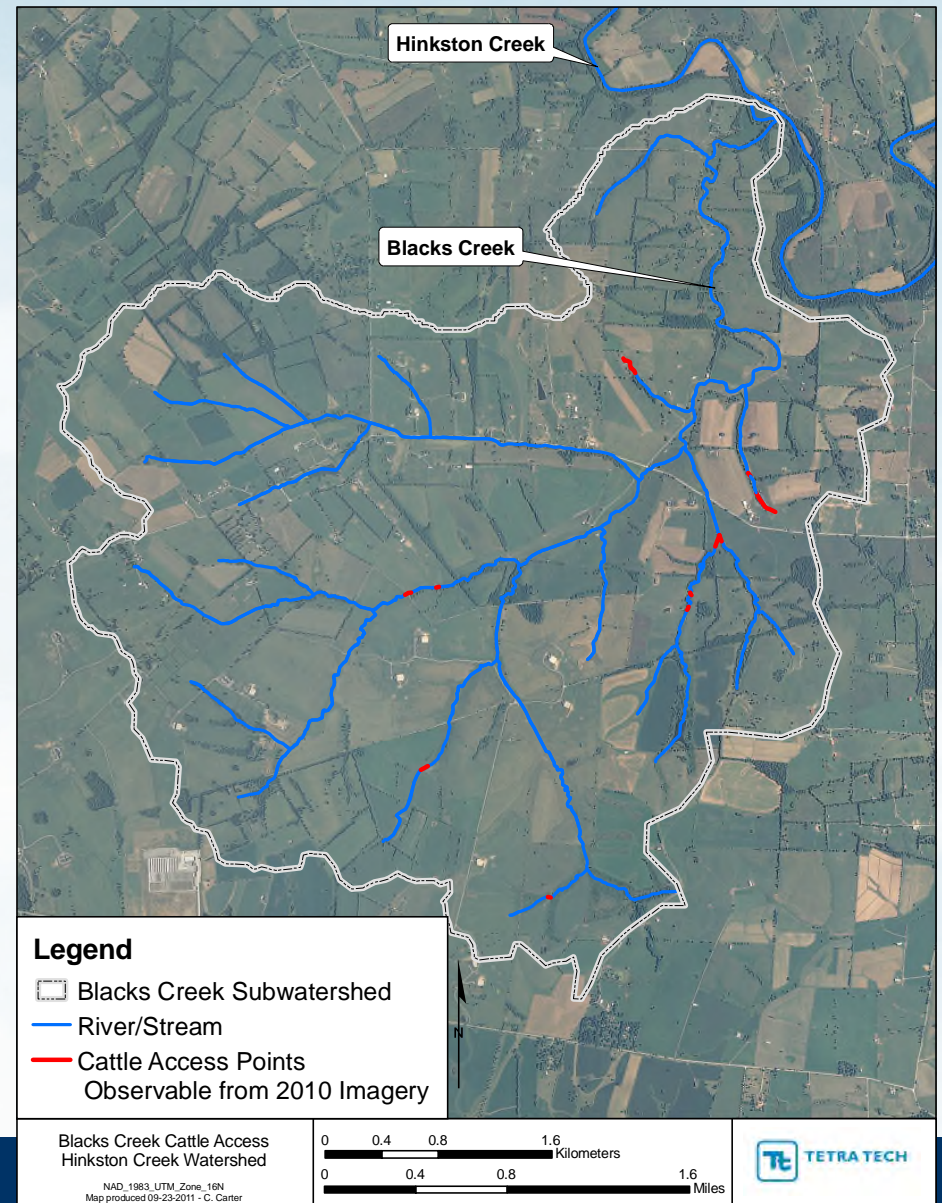
## ► Tailored analysis:

- Overlaid aerial imagery with riparian deficiency
- Visually scanned impacted reaches
- Assessed the intensity of impact on riparian areas based on the landcover context of the riparian buffer



# High-risk Stream Channel Assessment

- ▶ Cattle access points
  - Visible along some reach segments from the aerial imagery
  - Evidence of bare stream or pond bank



# High-risk Stream Channel Assessment: Data

- ▶ Riparian buffer deficiency
  - Data derived by Tetra Tech during previous analysis
  - Used to focus attention on impacted buffers
- ▶ Landcover context
  - National Agriculture Imagery Program (NAIP) imagery acquired during the agricultural growing season in 2010
  - Used to assess the intensity of impact based on surrounding land cover

# High-risk Stream Channel Assessment

- ▶ Impacted riparian areas were divided into four levels of impact based on stress conditions observable from the aerial imagery

## Stress Conditions:

- Proximity of intense tilling and/or grazing to the stream edge
- Evidence of cattle access points
- Lack of tree or shrub cover in the riparian buffer

- ▶ Best professional judgment was used to assign a level of impact to each reach segment

# High-risk Stream Channel Assessment

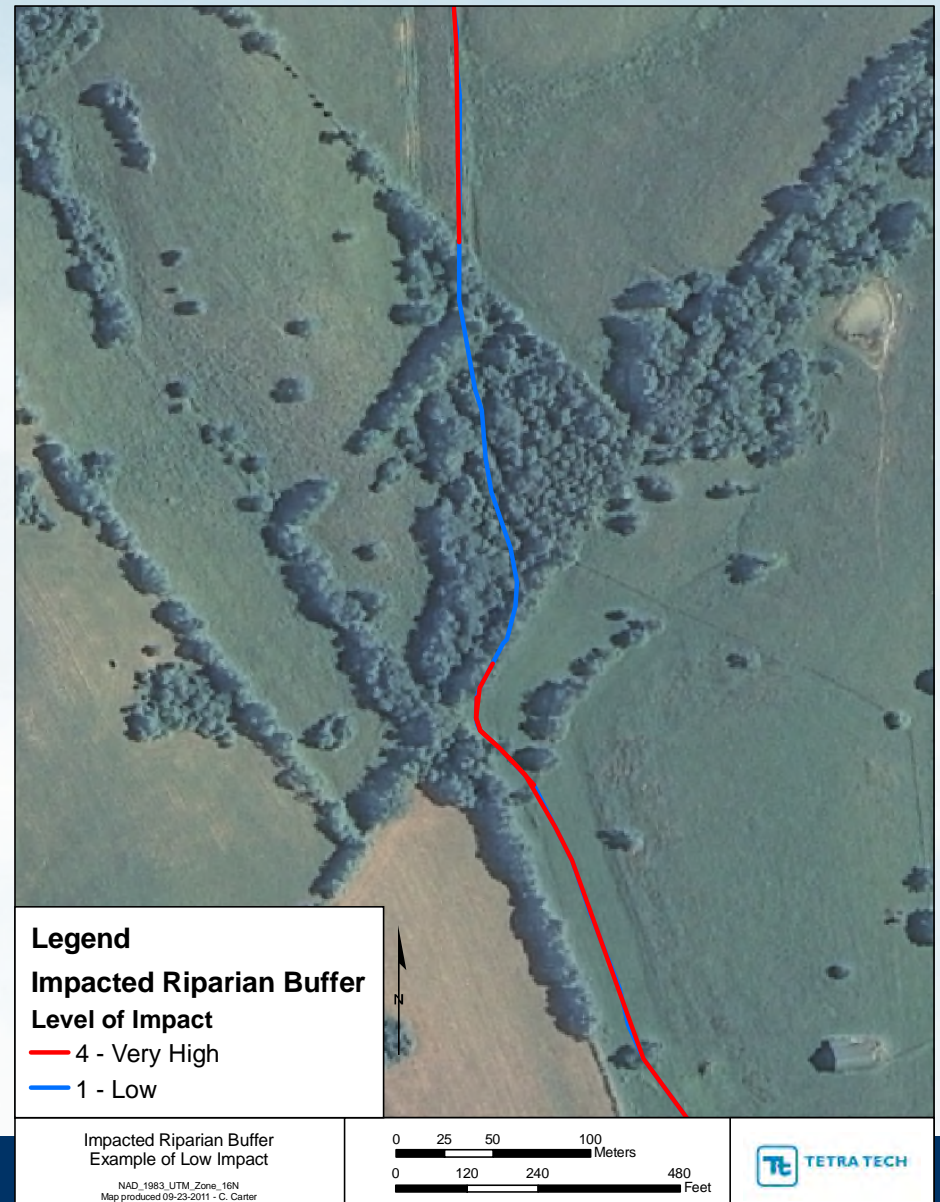
## ► Definition for each level of impact:

Level of Impact	Definition
1	Low <sup>1</sup> – Reaches that appear to be under low stress conditions. There is observable evidence of riparian protection consisting of tree lines or considerable scrub/shrub areas along both sides of the stream and/or evidence of intense tilling and/or grazing is an acceptable distance from stream edges.
2	Moderate - Reaches that appear to be under slightly stressed conditions and are surrounded by agricultural areas but there is observable evidence of riparian protection. Evidence of riparian protection consists of an observable tree line or scrub/shrub area along at least one side of the stream and/or intense tilling and/or grazing do not appear to be directly adjacent to stream edges.
3	High - Reaches that appear to be under moderately stressed conditions and are surrounded by agricultural areas but there is some observable evidence of riparian protection. Evidence of riparian protection consists of an observable fence line and/or intense tilling and/or grazing do not appear to be directly adjacent to stream edges.
4	Very High - Reaches that appear to be under severely stressed conditions and are surrounded by agricultural areas; there is no apparent riparian protection. Intense tilling and/or grazing are directly adjacent to stream edges and/or there is a noticeable cattle access point to the stream.

<sup>1</sup>Reaches identified as having a low level of impact may have sources of impact that are not visible from aerial imagery, such as cattle access points that are under the tree canopy. Ground truthing is strongly recommended for these reaches to ensure the correct level of impact has been captured.

# High-risk Stream Channel Assessment

- Low level of impact (Level 1)



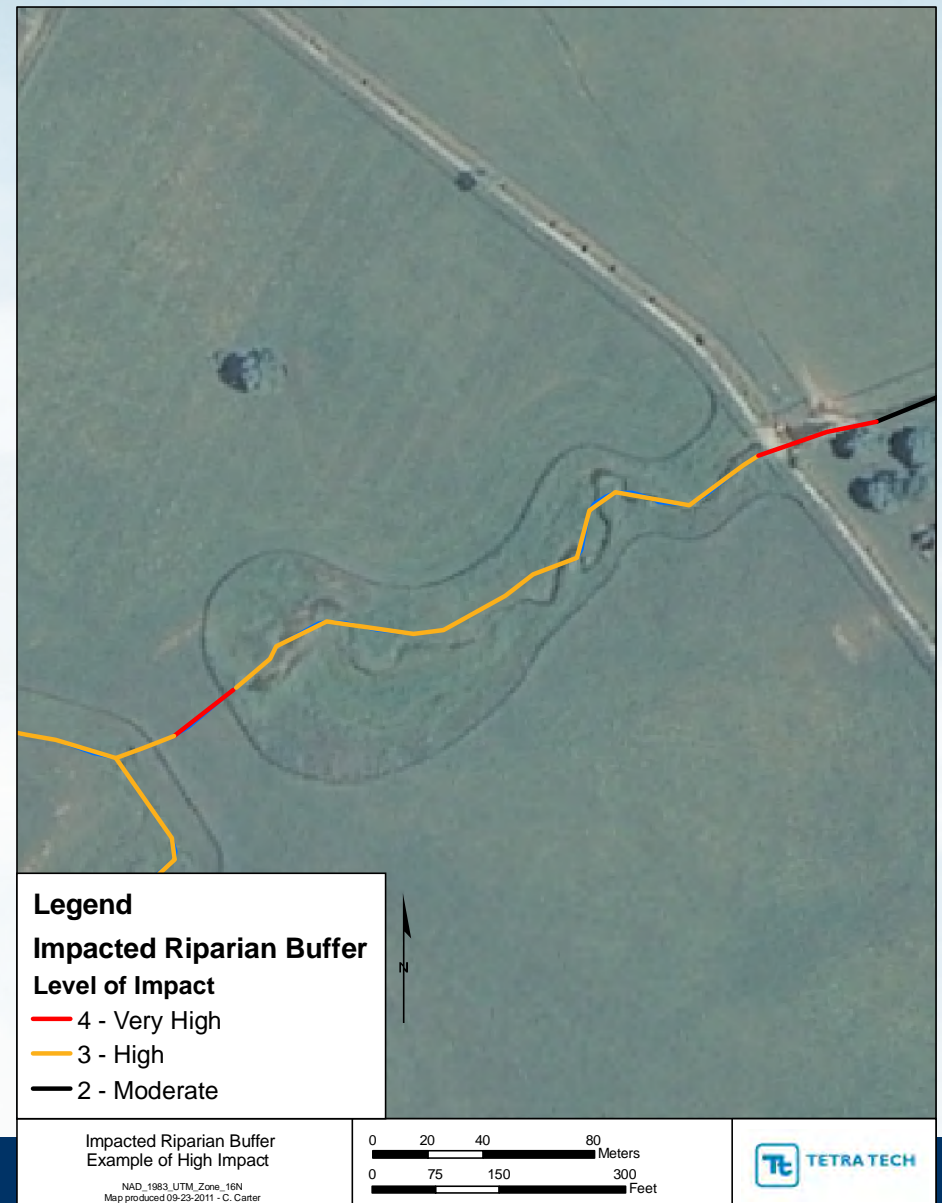
# High-risk Stream Channel Assessment

- Moderate level of impact (Level 2)



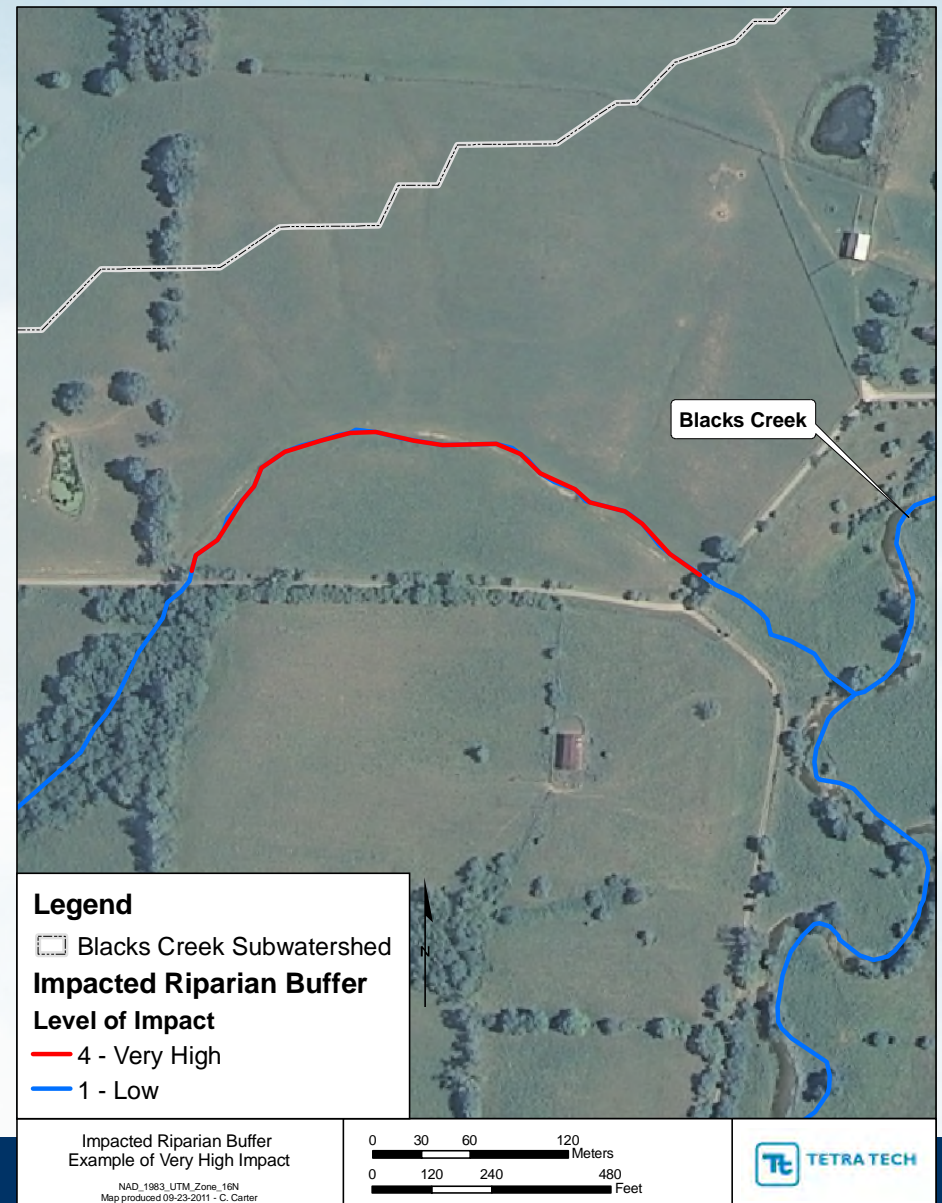
# High-risk Stream Channel Assessment

- High level of impact (Level 3)



# High-risk Stream Channel Assessment

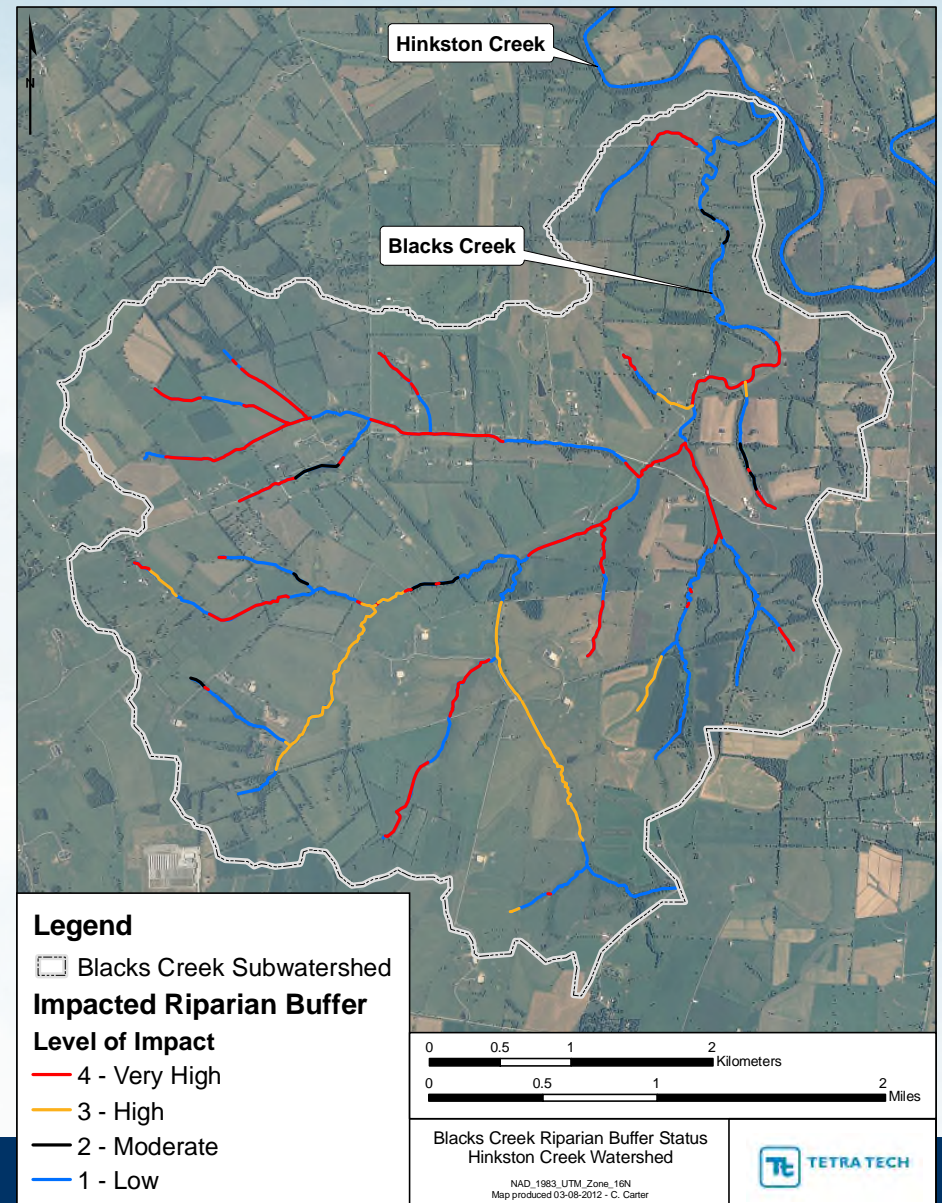
- Very High level of impact (Level 4)



# High-risk Stream Channel Assessment

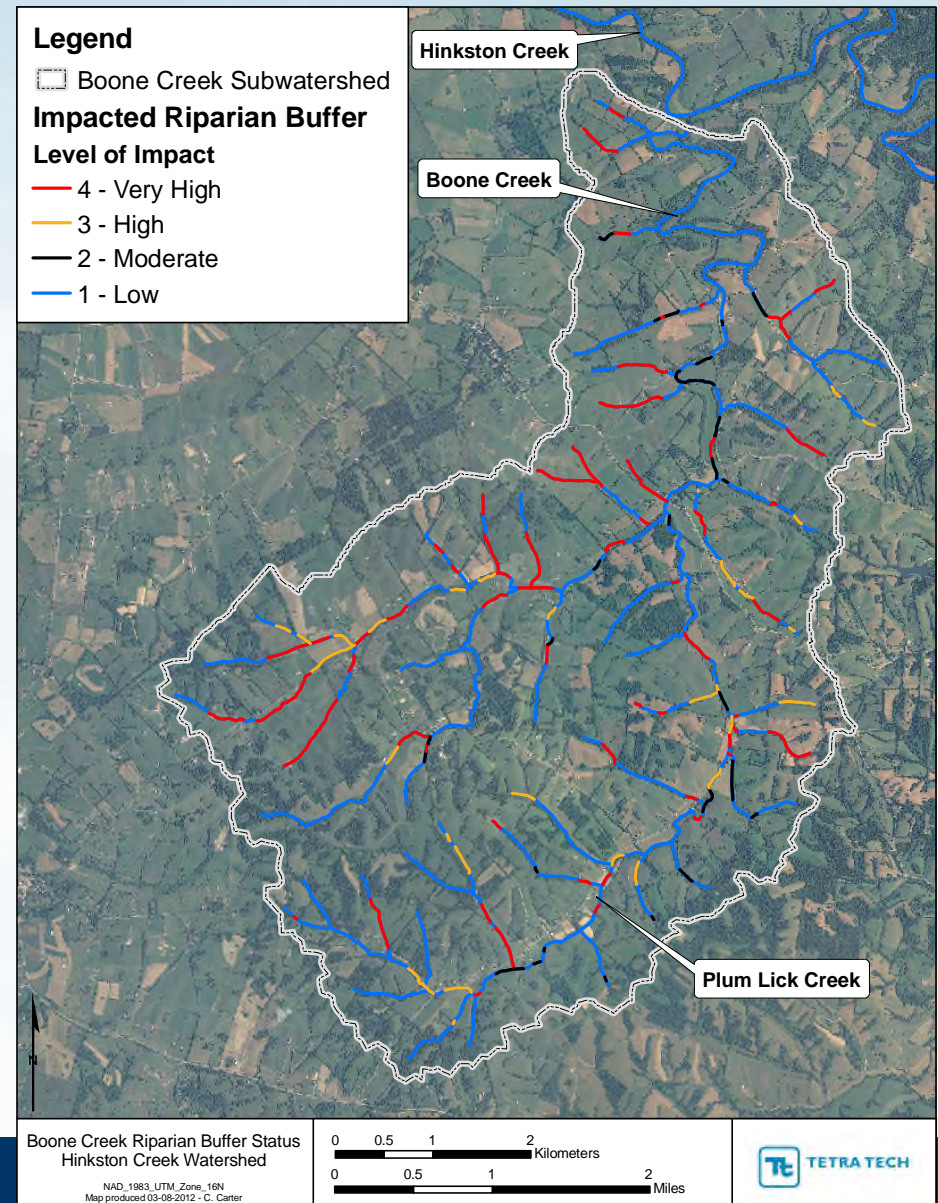
## ► Results – Blacks Creek

- Percent of Very High impact level (Level 4):
  - 33% of total reach length (35km)
- Percent of Low impact level (Level 1):
  - 48%



# High-risk Stream Channel Assessment

- Results – Boone Creek
  - Percent of Very High impact level (Level 4):
    - 22% of total reach length (74km)
  - Percent of Low impact level (Level 1):
    - 65%
- Identified parcel owners for high-risk areas to support BMP implementation efforts



# Use of Remote Sensing Tools

- GIS mapping
- Aerial photography
- Tailored analysis



Identify  
high-risk  
areas



Identify  
pollutant  
sources and  
target  
management  
practices

<b>Best Management Practice Name</b>	<b>Best Management Practice Units</b>	<b>Total Acres Impacted by BMP Installation</b>	<b>Type of Land Use Impacted by BMP Installation</b>	<b>Number of Farm Animals</b>	<b>Type of Farm Animals</b>
Stream Fencing	16,100 Feet	500	Pasture	125	Cattle
Stream Fencing	11,500 Feet	400	Pasture	50	Cattle
Stream Fencing	5,700 Feet	150	Pasture	50	Cattle
Stream Fencing	3,678 Feet	150	Pasture	50	Cattle
Heavy Use Area	1 HUA	40	Pasture	30	Cattle
Dump Cleanup	1 Waste Site	40	Pasture	30	Cattle
Stock Water Tank	1 Tank	150	Pasture	50	Cattle
Heavy Use Area	1 HUA	150	Pasture	50	Cattle
Stream Crossing	1 Crossing	40	Pasture	125	Cattle
Stock Water Tank	1 Tank	10	Pasture	125	Cattle
Stream Crossing	2 Crossings	10	Pasture	50	Cattle
Stock Water Tank	1 Tank	10	Pasture	50	Cattle
Stream Crossing	1 Crossing	10	Pasture	50	Cattle
Stock Water Tank	1 Tank	10	Pasture	50	Cattle
Stream Crossing	1 Crossing	150	Pasture	75	Cattle
Stock Water Tank	1 Tank	150	Pasture	75	Cattle
Stream Fencing	3,000 Feet	150	Pasture	75	Cattle
Heavy Use Area	1 HUA	100	Pasture	25	Cattle
Seeding	45 Acres	45	Pasture	15	Cattle
Seeding	170 Acres	170	Pasture	20	Cattle
Stream Fencing	2,512 feet	40	Pasture	20	Cattle
Stock Water Tank	1 Tank	40	Pasture	20	Cattle

<b>Best Management Practice Name</b>	<b>Best Management Practice Units</b>	<b>Total Acres Impacted by BMP Installation</b>	<b>Type of Land Use Impacted by BMP Installation</b>	<b>Number of Farm Animals</b>	<b>Type of Farm Animals</b>
Stock Water Tank	2 Tanks	40	Pasture	20	Cattle
Stream Fencing	700 feet	10	Pasture	15	Cattle
Seeding	10 Acres	10	Pasture	8	Cattle
Stock Water Tank	2 Tanks	15	Pasture	40	Cattle
Heavy Use Area	1 HUA	10	Pasture	20	Cattle
Seeding	75 Acres	75	Pasture	30	Cattle
Stream Fencing	2,000 Feet	35	Pasture	25	Cattle
Stock Water Tank	1 Tank	10	Pasture	15	Cattle
Stream Fencing	1,800 Feet	250	Pasture	60	Cattle
Stock Water Tank	1 Tank	10	Pasture	60	Cattle
Stock Water Tank	1 Tank	20	Pasture	10	Cattle
Heavy Use Area	1 HUA	20	Pasture	10	Cattle
Seeding	35 Acres	35	Pasture	15	Cattle
Seeding	35 Acres	35	Pasture	15	Cattle
Stream Fencing	1,200 Feet	25	Pasture	15	Cattle
Seeding	200 Acres	200	Pasture	30	Cattle
Seeding	70 Acres	70	Pasture	30	Cattle
Stream Fencing	1,000 Feet	30	Pasture	20	Cattle
Stock Water Tank	1 Tank	30	Pasture	20	Cattle
Stream Crossing	1 Crossing	40	Pasture	15	Cattle

# Thank you!

- ▶ Kentucky Division of Conservation
  - Angie Wingfield
  - Crystal Renfro
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  - Jim Roe (Nonpoint Source)
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  - Ann Fredenburg (TMDL)
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